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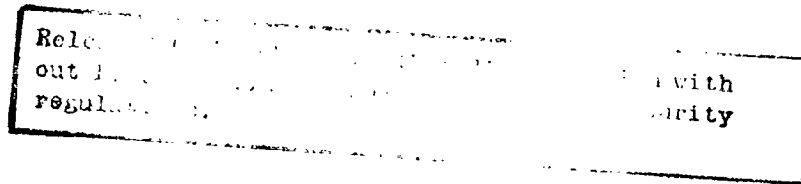
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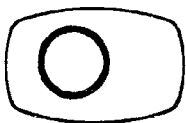
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THE WEDGE-RING JOINT

... a new method of joining
cylindrical sections.



MICHELSON LABORATORIES
U.S. NAVAL ORDNANCE TEST STATION

CHINA LAKE, CALIFORNIA • JUNE 1961

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FOREWORD

For some years, underwater-ordnance engineers have been interested in improving the design of joints used to connect sections of torpedoes. Recently, a new device, the wedge-ring joint, was designed, and patent proceedings were started. The joint was tested by the Aerojet General Corp., which found it structurally satisfactory and a significant improvement over other joints.

This article appears with the expectation that it may be of interest to shops and to designers in the ordnance and missile field.

This article has been reviewed for technical accuracy by David W. Anderson, Head of the Product Engineering Branch, Underwater Ordnance Department.

H. G. WILSON
Associate Technical Director

This document—Technical Article 12, NOTS TP 2643—is one in a series of technical articles styled for those outside as well as inside the subject field. Published by the Publishing Division of the Technical Information Department, it consists of 4 leaves and unbound abstract cards; first printing, June 1961, 510 copies.



Mr. Hillmer, an engineering technician in the Product Engineering Division of the Underwater Ordnance Department, joined the Design and Production Department of the U. S. Naval Ordnance Test Station, Pasadena, in 1946 doing production planning and production engineering work on the 2.75-inch rockets, the 5-inch Zuni rockets, and the Abel project.

Transferring in 1954 to the Underwater Ordnance Department, he did contractor liaison work on the EX-2 torpedo. At present he is doing liaison and production engineering work on the ASROC project and on the Mk 46 torpedo.

Before joining NOTS, Mr. Hillmer was Production Manager for a machine tool manufacturer on the East Coast. Mr. Hillmer is the designer of the device described in this article, and patent proceedings have been started in his name.

He resides with his wife and daughter in Pasadena.

THE WEDGE-RING JOINT¹

by W. Hillmer

The weight and space limitations of air-launched and rocket-projected torpedoes present unusual challenges to the engineer and designer. One of the more difficult problems to answer in a wholly satisfactory manner has been the joining of the sections of a torpedo.

This problem has grown increasingly difficult in recent years. While the over-all diameter of aircraft-launched torpedoes has decreased, both the performance of torpedoes and the stresses that they are required to withstand have increased.

Methods of joining torpedo sections that were used previously (principally the clamp-ring method) have two major failings:

First, those methods are wasteful of space. For example, the clamp-ring joint has a wall thickness of $1\frac{1}{4}$ inches, and the wedge-ring joint has a wall thickness of only $\frac{7}{16}$ inch. This is a saving of more than 1 inch in diameter.

¹ Patent applied for.

THE WEDGE-RING JOINT

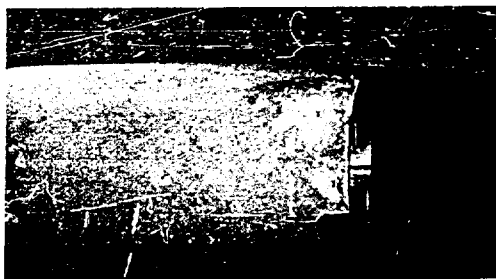


FIG. 1. Exterior of a Clamp-Ring Joint.

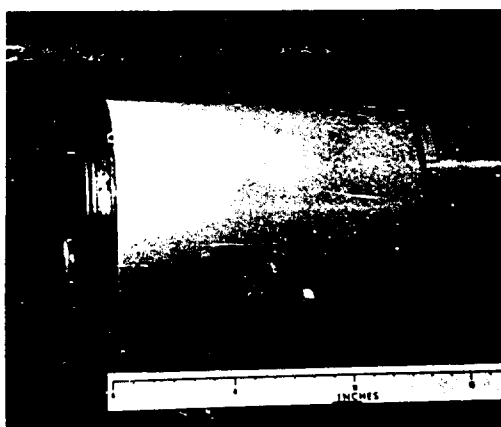


FIG. 2. One Complete Wedge-Ring Joint and Half of Another. Note the smooth surface of the joint located above the 15-inch mark on the scale. Only the cover plate of the joint is obvious. The circle, on the incomplete joint, indicates the hole that the registration pin engages.

Second, in the clamp-ring and earlier joints, there is usually a considerable gap between the sections (Fig. 1). These gaps cause turbulence in the flow of water past the torpedo's skin. The wedge-ring joint has a very smooth exterior (Fig. 2). This is important in reducing the hydrodynamic noise generated by the passage of the torpedo through the water. Reduction of this noise can contribute greatly to the effectiveness of an acoustic homing torpedo.

The wedge-ring joint has several other advantages over previous joints. The wedge ring is lighter—the two wedge rings and cover plate of a typical wedge-ring installation (Fig. 3a) weigh 0.8 pound, compared with 5.0 pounds for the clamp-ring joint (Fig. 3b) used in a similar application. The two wedge rings fill the groove, full width and full depth, to make a rigid and strong connection, while forcing the ends of the cylinder sections tightly together for a good alignment. One of the wedge rings has a pin in the wide end that locates and locks the wedge ring to the male cylinder section. The other wedge ring can be displaced circumferentially and axially until it fills the groove, and the cylinder sections are forced together. Thus, the combined width of the two wedge rings adjusts to make up the tolerance allowed for manufacturing, and, at the same time, forces the cylinder sections together.

ASSEMBLY AND DISASSEMBLY PROCEDURES

The assembly procedure for the wedge-ring joint is simple and lends itself to both production and test procedures.

After the torpedo sections are joined, the wedge rings are assembled from outside through a rectangular hole in the outer cylinder in line with the ring groove. The narrow end of one wedge ring is inserted and pushed in until a pin in the wide end of the ring engages a hole in the inner cylinder, locking the ring in place. The second ring is inserted in the opposite direction and driven in until the ends of the two cylinder sections butt tightly together (see section B-B of Fig. 4). A spacer, cut to the required length and placed between the ends, locks the rings in place.

(a) The wedge rings and cover plate of a wedge-ring joint. On the right is the special tool used in assembly and disassembly. The wheels permit the tool to be rolled around the outside of the torpedo casing as the ring is inserted or withdrawn.



(b) The clamp ring previously used.

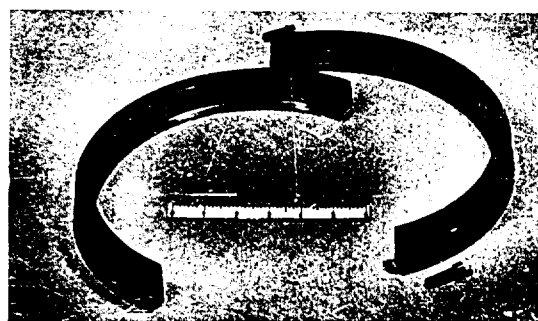


FIG. 3. Comparison of the Wedge Ring and the Clamp Ring.

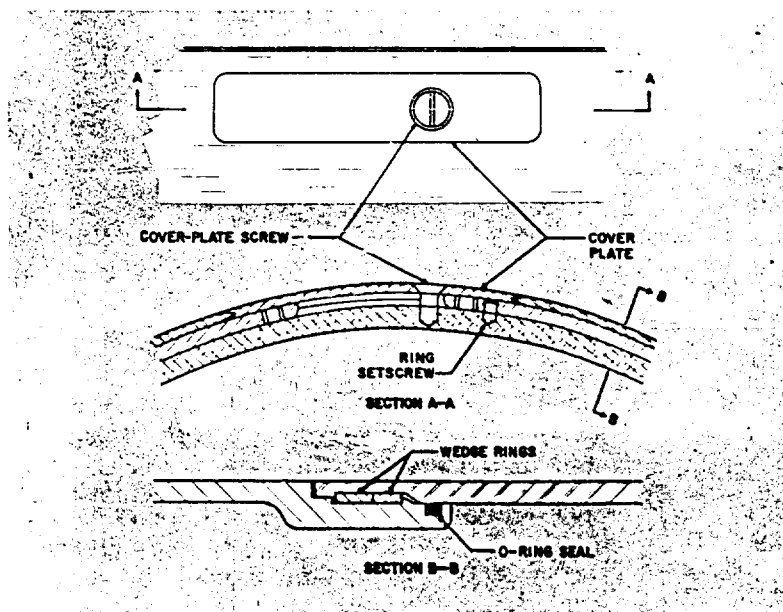


FIG. 4. Three Views of the Cover-Plate Area of a Wedge-Ring Joint. The rings can be waterproofed in equipment that will be stored in a wet environment for long periods of time by locating the O-ring on the side of the wedge rings nearest to the exterior.

THE WEDGE-RING JOINT

The rectangular opening in the outside cylinder is closed by a cover plate, held in place with a flat-headed screw (Fig. 5).

To disassemble the joint, the cover plate and the spacer are removed and the wedge ring without pin is withdrawn first, using the special tool (Fig. 6). The tool is used by inserting the threaded bolt into the $\frac{1}{4}$ -28 tapped hole in the wide end of the wedge ring. Rotation of the tool about the axis of the rollers lifts the wide end of the wedge ring through and above the slot in the outer cylinder. The wedge ring may then be pulled from the groove by rolling the tool around the cylinder. After the second wedge ring has been similarly removed, the telescoping ends of the cylinder sections can be separated.

TEST RESULTS

The wedge-ring joint has been subjected to a number of tests in the course of the development program at the U. S. Naval Ordnance Test Station. In a static load test, a prototype 12 $\frac{1}{4}$ -inch-diameter joint withstood a body-bending moment of 125,000 in-lb and a lateral shear load of 8,000 pounds without permanent deformation at any point. External pressure of 750 psig was also applied to test the joint for sealability. No leakage resulted.

A structural dummy with wedge-ring joints withstood aircraft launching at 165 knots and water entry at a 29-degree angle.

The joint has not been tested to destruction.

MATERIALS AND MANUFACTURE

The original wedge rings and those in current use are made from 4130 steel, heat-treated to 30–35 on the Rockwell hardness scale, and plated with cadmium. (The heat treatment was added only to prevent kinking of the rings during assembly and disassembly.) The rings can also be made from stainless steel or hard anodized aluminum.

The wedge rings are at present manufactured from steel plate, rolled and welded to the desired diameter. The resulting cylinder is then turned and bored to the finished diameter. The taper is machined using an end mill on a milling machine that is geared to the correct lead. In large-scale production, the taper would be milled or planed on flat strips that would then be rolled to the required diameter.

APPLICATIONS

This type of joint can be used wherever light weight and a thin cross section are required. Several variations have been designed with individual characteristics for special application. The wedge-ring joint has already shown that it has advantages in applications to underwater ordnance. It is possible that similar advantages also exist in the application of the wedge-ring joint to aircraft and missiles.

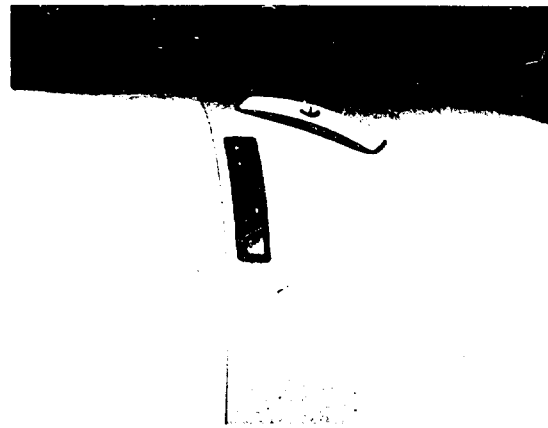


FIG. 5. Assembled Wedge-Ring Joint With Cover Plate Removed.



FIG. 6. Wedge-Ring Assembly and Disassembly Tool in Use.

ABSTRACT CARD

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ABSTRACT. This article presents a new method of joining sections of torpedoes. The wedge-ring joint has advantages over previous joints in size, weight, and ease of assembly. The joint provides a smooth joining surface; therefore, it reduces water turbulence around the torpedo, making it more effective.



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Fig. 1, LHL-P 19751; Fig. 2, LHL-P 22608-1; Fig. 3, (a) LHL-P 22588-2, (b) LHL-P 22588-3; Fig. 4, none; Fig. 5, LHL-P 22608-3; Fig. 6, LHL-P 22608-4.



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